Design and Construction of the Next Generation HIDEX Bathyphotometer

Dr. Edith Widder
Harbor Branch Oceanographic Institution
5600 U.S. 1 North, Fort Pierce, FL 34946
phone (561) 465-2400 x315 fax (561) 468-0757 email widder@hboi.edu

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LONG-TERM GOALS

My research objectives involve determining how low light phenomena, both bioluminescence and solar radiation below 200 meters, influence the distribution and behavior of marine organisms.

OBJECTIVES

To design and build the next generation of the HIDEX bathyphotometer, to meet bioluminescence survey requirements of the Naval Oceanographic Office.

APPROACH

This next generation instrument has been designed to incorporate commercial, off-the-shelf technologies wherever possible. Since the first generation HIDEX-BP (Widder, 1993) is now considered the standard for bioluminescence measurements by NAVOCEANO, the basic hydrodynamics and internal dimensions of the excitation/detection chamber have remained unchanged. Ancillary sensor suites have been upgraded to reflect current technology and meet expanded measurement requirements and software has been upgraded to be Windows compatible.

WORK COMPLETED

The HIDEX Gen II is nearly complete. All components have been received or are expected to arrive in the very near future. All instrumentation and custom electronics have been tested. The main tasks required for 100% completion are final assembly of all components, calibration of the PMTs, calibration of the flow meter, and at-sea testing.

RESULTS

Topside electronics are complete and awaiting final wiring. These include the power distribution box and the main control computer. The consoles serve as the housings as well as shipping containers for the electronics and main computer.

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Figure 1: Computer Console ***Figure 2: Power Console***

Software: The HIDEX II topside software package has been written in LabVIEW, and is bundled into a stand-alone executable with a self-extracting installer. This installer and user manual will be provided on a CD-ROM as well as the topside computer. The end-user does not need a copy of LabVIEW to use HIDEX II, and it may be installed onto other computers with permission from HBOI.

Since it's last design revision, the user interface has been streamlined, and less frequently used features have been hidden into menus. The image below shows the main HIDEX II panel.

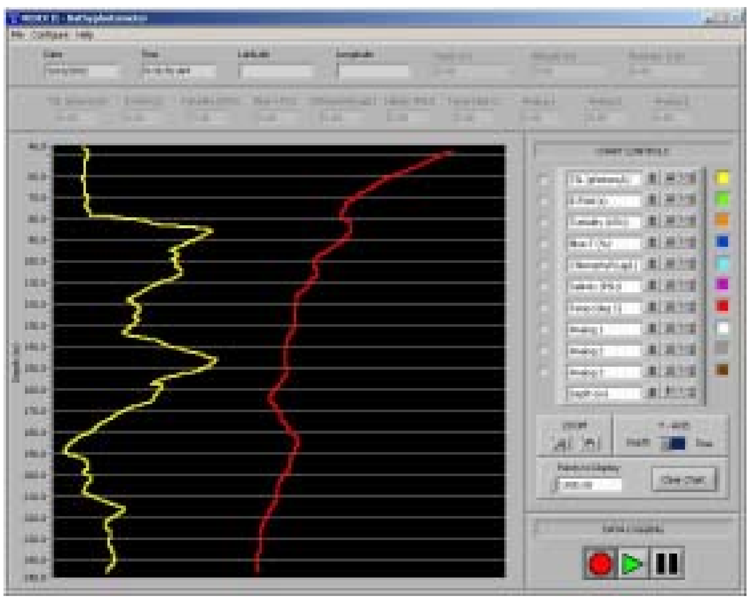

Figure 3: Computer screen for HIDEX II data readout [screen showing data profiles on left and user selectable readouts on right as listed below)

The sensors that are read by the HIDEX II software package include the following:

- 8-Zone Array PMTs (E-Fold)
- 1 Total Light PMT (TSL)
- 1 Light Scattering Sensor (Turbidity)
- 1 Blue Transmissometer (Blue-T)

- 1 Fluorimeter (Chlorophyll)
- 1 CTD (Temp, Salinity, Depth)
- 3 Spare analog channels (for any other 0-5 VDC devices)
- 1 GPS (Latitude & Longitude, sampled once per cast)

The Wet-Labs AC-9 Transmissometer is also present on the HIDEX II system, but is not interfaced into HBOI's software. The AC-9 is read by running WetLabs' WetView 6 software simultaneously.

Performance evaluations of the HIDEX II software have proven reliability at sampling rates up to 10Hz on all sensors, with expected limits much higher than that. Based on the original design specifications of the system, all sensors are being sampled at 2Hz. The PMTs are sampled at 10Hz and a 5-sample averaging routine is performed by the analog-to-digital converters, resulting in a 2Hz data read by the topside software. All data is coordinated with depth at the CTD's maximum output rate of 1Hz.

Data collected by the HIDEX II software package is post-processed by applying offset and multiplier values in order to convert raw data to engineering units, and compensate for any linear errors in the instruments (i.e. atmospheric pressure, calibration constants, etc). These processed data may be displayed on the main graph and logged, along with corresponding raw data into two tab-delimited text files. These text files can then be opened and edited using a spreadsheet program such as Microsoft Excel. Furthermore, images of the main panel can be saved (as HTML) or printed for use in reports.

Winch: The topside winch is 99% complete. The main umbilical has been spooled onto the drum and terminated. Load tests have been performed at our facility. The winch user controls have been fitted with a protective bolt on shipping cover. The last step is to wire the slip ring, which will be done at the same time the topside racks are wired. This should take no more than a week. The Sheave is on order and is due to be delivered in 3 weeks.

Figure 4: HIDEX-BP winch

The aluminum frame of the HIDEX is complete. It includes off-the-shelf protective rubber bumpers and reinforced front and rear sections. A small aluminum wheeled skid, (shown in photo), is provided as a means of rolling the HIDEX around a lab.

Figure 5 Two views of aluminum frame designed to support HIDEX-BP detection chamber.

All sensors have been mounted on the frame. The pressure housing brackets have been made. Only the detection chamber and pressure housings remain to be mounted to the frame.

The flow tube detection chamber is nearly complete with only the motor housing left to be fabricated. All other components have been fabricated including the stainless excitation screen, light baffle, flow meter, pump rotor and all light gathering wedges. The motor housing is currently in production and will be complete in one week. Final assembly of the chamber should take less than 3 days, where it will then be mounted in the frame.

Figure 6: HIDEX-BP flow tube detection chamber [with additiona components including excitation grid and light baffle, pump rotor and flow meter].

The bottom side electronics, including the PMT auto gain circuits are complete and have passed testing. The pressure housings for the electronics are also complete and anodized. Currently, the electronics are in the final wiring and mounting stage before being closed up inside their housings.

  

Figure 7: Power board ***Figure 8: Circuit boards and end cap*** ***Figure 9: End cap***

Fiber optics: All fiber optic cable ends have been terminated and are ready for connection from the PMT pressure housing to the detection chamber.

User manual: An on-line user manual is complete for the software. For hardware, all available instrument manuals as well as specification sheets on individual components are packaged for the end user, as well as pertinent drawings required for troubleshooting.

Future tasks: The following outstanding tasks are required to complete the HIDEX II unit.

1. Mount slip ring to winch.
2. Wire electrical boards and components in pressure housings.
3. Wire topside power distribution.
4. Wire all connectors.
5. Complete motor housing.
6. Mount detection chamber to frame.
7. Mount pressure housings to frame.
8. Connect all fibers from the detection chamber to the PMT housing.
9. Test all components while connected to control computer again.
10. Fabricate protective cover for fibers.
11. Use calibration wand to calibrate PMTs.
12. Submerge HIDEX unit and calibrate flow meter and pump for 18 liters per second.
13. At Sea Trials

Expected completion date is the end of October.

IMPACT/APPLICATIONS

The HIDEX-BP currently employed by NAVOCEANO for survey work was built in 1990 and is approaching the end of its useful lifetime. Much of the original construction was an integrated system that involved proprietary components that are not easily replaced and for which upgrades are not available. This second generation instrument employs a modular design and incorporates commercial off-the-shelf components wherever possible to facilitate long-term maintenance and to meet expanded measurement requirements.

TRANSITIONS

Upon completion, the HIDEX-BP will be transitioned to NAVOCEANO.

RELATED PROJECTS

With the development effort that we have been putting into the HIDEX-BP GEN 2 we have determined that there are a number of major changes that can be made in the instrument that would greatly decrease its production costs while increasing its utility. NAVOCEANO did not wish to implement these changes as their primary concern was maintaining compatibility with the GEN 1 database. We are therefore going to develop a prototype of the proposed GEN 3 system and test it against the HIDEX GEN 1. As part of this effort we will also be developing a bioluminescence calibration center. This facility will be used for the calibration of HIDEX GEN 2 and Gen 3 as well as for cross calibration of HIDEX with some of the smaller BPs currently in use.

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